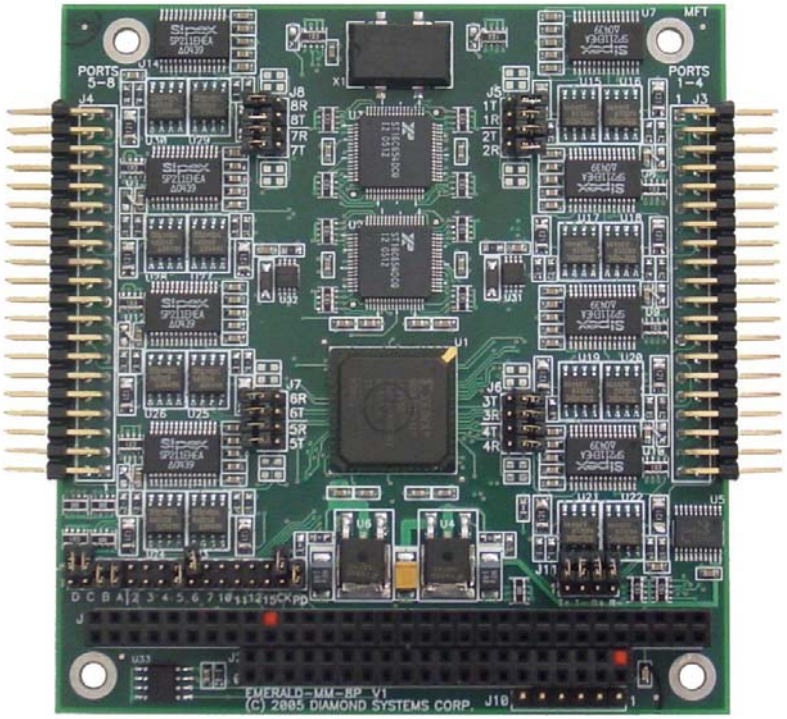
# DIAMOND SYSTEMS CORPORATION

# EMERALD-MM-8P

***8-Channel Software Programmable Protocol***

***Serial Port PC/104 Module***

User Manual V1.10

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# EMERALD-MM-8P

***8-Channel Software Configurable Protocol Serial Port PC/104 Modules***

## 1. DESCRIPTION

Emerald-MM-8P is a PC/104 I/O module with 8 serial ports with protocols that are software programmable.

I/O addresses and interrupt levels are programmable for each port, allowing maximum configuration flexibility. For applications where fixed addresses are desirable, four groups of preset addresses are provided that can be selected by jumper settings.

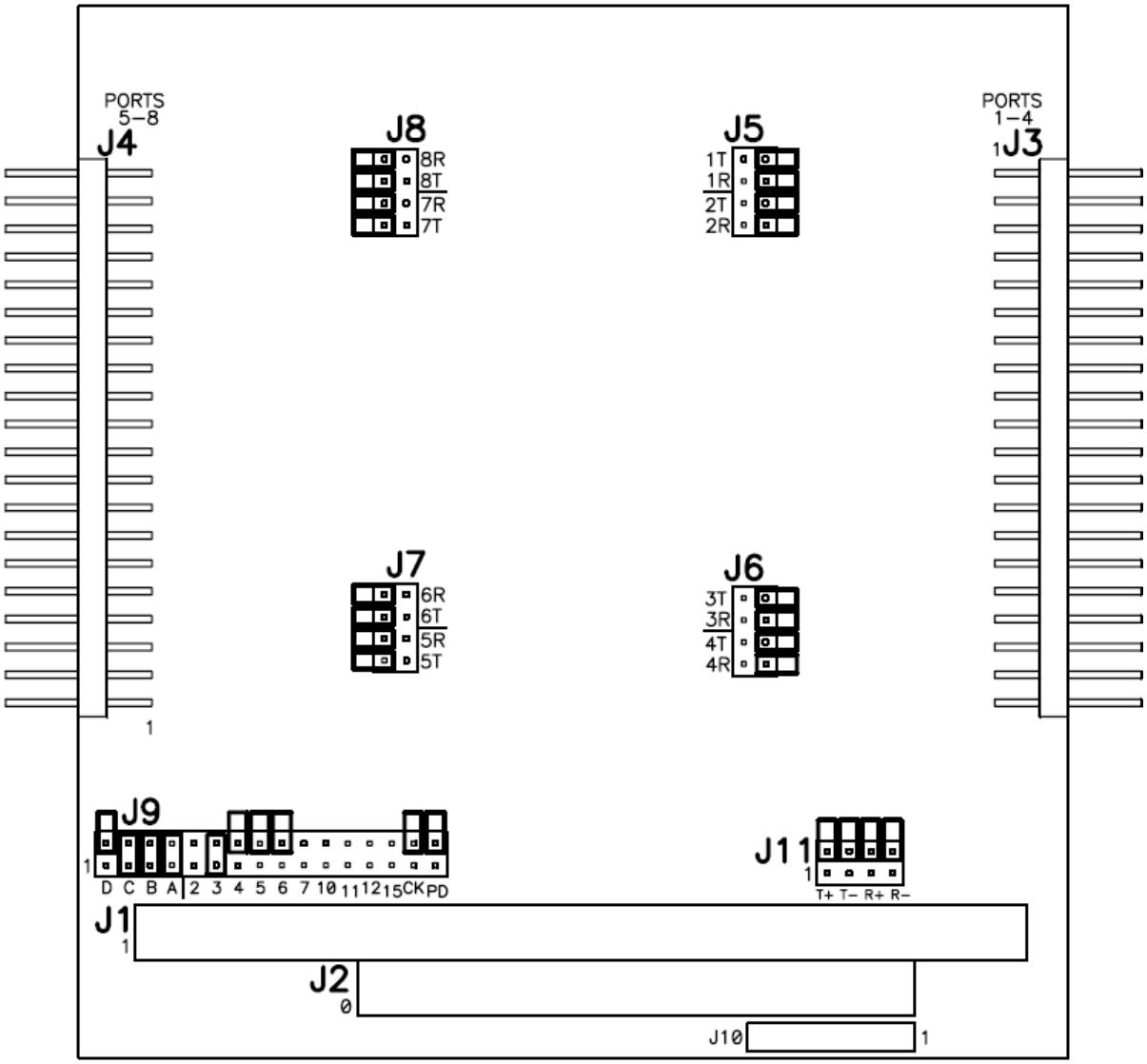
Two I/O headers are provided, with four serial ports on each header. The board operates on +5V only, eliminating the need for a +12V supply that is often required for serial port operation.

Emerald-MM-8P is based on the 16C654 quad serial port IC. This device contains 4 identical sets of registers, one for each port, and is compatible with the standard PC serial port. Each port contains a 16-byte FIFO. Complete descriptions of these registers may be found in the Appendix. Most users will not need this programming information, as it is normally handled by the operating system's communications software.

## 2. FEATURES

- 8 serial ports with 16-byte FIFOs.
- Software Configurable RS-232 / RS-422 / RS-485.
- Up to 115.2kbps in standard configuration (up to 460.8kbps available).
- Software selectable I/O addresses and interrupt levels.
- EEPROM storage of configuration data for instant availability on power-up.
- I/O lines are short circuit protected.
- 8 programamble digital I/O lines (1 per port).
- Dual 40-pin I/O headers, 4 ports per header.
- +5V only operation.
- Extended temperature (-40$^{o}$C to +85$^{o}$C) operation.
- PC/104 form factor.

## 3. EMERALD-MM-8P BOARD DRAWING




J1: PC/104 bus 8-bit connector

J2: PC/104 bus 16-bit connector

J3: I/O header for ports 1 – 4 (2x20 pins) + 4 DIO

J4: I/O header for ports 5 – 8 (2x20 pins) + 4 DIO

J5 – J8: Termination jumper blocks, two ports per block

J9: Board address and interrupt pull-down resistor configuration

J10: JTAG Programming Connector

J11: Bias Resistor Enable Jumper Block for Port 4

## 4. I/O HEADER PINOUTS

Emerald-MM-8P provides two identical 40-pin headers labeled J3 and J4 for the serial ports. Four ports are contained on each header. Pin numbers are marked on the board to assist with connector orientation.

Depending on the model you have, each port may be fixed in a single protocol or configurable for different protocols. The template connector pinouts below are provided to show the pinout for each port in each configuration. The actual pinout of each connector will depend on the model you have and the configuration you have set for each port.

**RS-232 Configuration:**

**J3**

| | | | | |
|---|---|---|---|---|
| Port 1 | DCD 1 | **1** | **2** | DSR 1 |
| | RXD 1 | **3** | **4** | RTS 1 |
| | TXD 1 | **5** | **6** | CTS 1 |
| | DTR 1 | **7** | **8** | RI 1 |
| | GND | **9** | **10** | DIO A |
| Port 2 | DCD 2 | **11** | **12** | DSR 2 |
| | RXD 2 | **13** | **14** | RTS 2 |
| | TXD 2 | **15** | **16** | CTS 2 |
| | DTR 2 | **17** | **18** | RI 2 |
| | GND | **19** | **20** | DIO B |
| Port 3 | DCD 3 | **21** | **22** | DSR 3 |
| | RXD 3 | **23** | **24** | RTS 3 |
| | TXD 3 | **25** | **26** | CTS 3 |
| | DTR 3 | **27** | **28** | RI 3 |
| | GND | **29** | **30** | DIO C |
| Port 4 | DCD 4 | **31** | **32** | DSR 4 |
| | RXD 4 | **33** | **34** | RTS 4 |
| | TXD 4 | **35** | **36** | CTS 4 |
| | DTR 4 | **37** | **38** | RI 4 |
| | GND | **39** | **40** | DIO D |

**J4**

| | | | | |
|---|---|---|---|---|
| Port 5 | DCD 5 | **1** | **2** | DSR 5 |
| | RXD 5 | **3** | **4** | RTS 5 |
| | TXD 5 | **5** | **6** | CTS 5 |
| | DTR 5 | **7** | **8** | RI 5 |
| | GND | **9** | **10** | DIO E |
| Port 6 | DCD 6 | **11** | **12** | DSR 6 |
| | RXD 6 | **13** | **14** | RTS 6 |
| | TXD 6 | **15** | **16** | CTS 6 |
| | DTR 6 | **17** | **18** | RI 6 |
| | GND | **19** | **20** | DIO F |
| Port 7 | DCD 7 | **1** | **2** | DSR 7 |
| | RXD 7 | **3** | **4** | RTS 7 |
| | TXD 7 | **5** | **6** | CTS 7 |
| | DTR 7 | **7** | **8** | RI 7 |
| | GND | **9** | **10** | DIO G |
| Port 8 | DCD 8 | **11** | **12** | DSR 8 |
| | RXD 8 | **13** | **14** | RTS 8 |
| | TXD 8 | **15** | **16** | CTS 8 |
| | DTR 8 | **17** | **18** | RI 8 |
| | GND | **19** | **20** | DIO H |

**RS-422 Configuration:**

**J3**

| | | | | |
|---|---|---|---|---|
| Port 1 | NC | **1** | **2** | NC |
| | TXD+ 1 | **3** | **4** | TXD- 1 |
| | GND | **5** | **6** | RXD- 1 |
| | RXD+ 1 | **7** | **8** | NC |
| | GND | **9** | **10** | DIO A |
| Port 2 | NC | **11** | **12** | NC |
| | TXD+ 2 | **13** | **14** | TXD- 2 |
| | GND | **15** | **16** | RXD- 2 |
| | RXD+ 2 | **17** | **18** | NC |
| | GND | **19** | **20** | DIO B |
| Port 3 | NC | **21** | **22** | NC |
| | TXD+ 3 | **23** | **24** | TXD- 3 |
| | GND | **25** | **26** | RXD- 3 |
| | RXD+ 3 | **27** | **28** | NC |
| | GND | **29** | **30** | DIO C |
| Port 4 | NC | **31** | **32** | NC |
| | TXD+ 4 | **33** | **34** | TXD- 4 |
| | GND | **35** | **36** | RXD- 4 |
| | RXD+ 4 | **37** | **38** | NC |
| | GND | **39** | **40** | DIO D |

**J4**

| | | | | |
|---|---|---|---|---|
| Port 5 | NC | **1** | **2** | NC |
| | TXD+ 5 | **3** | **4** | TXD- 5 |
| | GND | **5** | **6** | RXD- 5 |
| | RXD+ 5 | **7** | **8** | NC |
| | GND | **9** | **10** | DIO E |
| Port 6 | NC | **11** | **12** | NC |
| | TXD+ 6 | **13** | **14** | TXD- 6 |
| | GND | **15** | **16** | RXD- 6 |
| | RXD+ 6 | **17** | **18** | NC |
| | GND | **19** | **20** | DIO F |
| Port 7 | NC | **1** | **2** | NC |
| | TXD+ 7 | **3** | **4** | TXD- 7 |
| | GND | **5** | **6** | RXD- 7 |
| | RXD+ 7 | **7** | **8** | NC |
| | GND | **9** | **10** | DIO G |
| Port 8 | NC | **11** | **12** | NC |
| | TXD+ 8 | **13** | **14** | TXD- 8 |
| | GND | **15** | **16** | RXD- 8 |
| | RXD+ 8 | **17** | **18** | NC |
| | GND | **19** | **20** | DIO H |

**RS-485 Configuration:**

**J3**

| | | | | |
|---|---|---|---|---|
| Port 1 | NC | 1 | 2 | NC |
| | TXD/RXD+ 1 | 3 | 4 | TXD/RXD- 1 |
| | GND | 5 | 6 | NC |
| | NC | 7 | 8 | NC |
| | GND | 9 | 10 | DIO A |
| Port 2 | NC | 11 | 12 | NC |
| | TXD/RXD+ 2 | 13 | 14 | TXD/RXD- 2 |
| | GND | 15 | 16 | NC |
| | NC | 17 | 18 | NC |
| | GND | 19 | 20 | DIO B |
| Port 3 | NC | 21 | 22 | NC |
| | TXD/RXD+ 3 | 23 | 24 | TXD/RXD- 3 |
| | GND | 25 | 26 | NC |
| | NC | 27 | 28 | NC |
| | GND | 29 | 30 | DIO C |
| Port 4 | NC | 31 | 32 | NC |
| | TXD/RXD+ 4 | 33 | 34 | TXD/RXD- 4 |
| | GND | 35 | 36 | NC |
| | NC | 37 | 38 | NC |
| | GND | 39 | 40 | DIO D |

**J4**

| | | | | |
|---|---|---|---|---|
| Port 5 | NC | 1 | 2 | NC |
| | TXD/RXD+ 5 | 3 | 4 | TXD/RXD- 5 |
| | GND | 5 | 6 | NC |
| | NC | 7 | 8 | NC |
| | GND | 9 | 10 | DIO E |
| Port 6 | NC | 11 | 12 | NC |
| | TXD/RXD+ 6 | 13 | 14 | TXD/RXD- 6 |
| | GND | 15 | 16 | NC |
| | NC | 17 | 18 | NC |
| | GND | 19 | 20 | DIO F |
| Port 7 | NC | 1 | 2 | NC |
| | TXD/RXD+ 7 | 3 | 4 | TXD/RXD- 7 |
| | GND | 5 | 6 | NC |
| | NC | 7 | 8 | NC |
| | GND | 9 | 10 | DIO G |
| Port 8 | NC | 11 | 12 | NC |
| | TXD/RXD+ 8 | 13 | 14 | TXD/RXD- 8 |
| | GND | 15 | 16 | NC |
| | NC | 17 | 18 | NC |
| | GND | 19 | 20 | DIO H |

## 5. I/O HEADER PIN DEFINITIONS

| Signal Name | Definition | Direction |
|---|---|---|
| **RS-232:** | | |
| DCD | Data Carrier Detect | Input |
| DSR | Data Set Ready | Input |
| RXD | Receive Data | Input |
| RTS | Request To Send | Output |
| TXD | Transmit Data | Output |
| CTS | Clear To Send | Input |
| DTR | Data Terminal Ready | Output |
| RI | Ring Indicator | Input |
| **RS-422:** | | |
| TXD+, TXD- | Differential Transmit Data | Output |
| RXD+, RXD- | Differential Receive Data | Input |
| **RS-485:** | | |
| TXD/RXD+ | Differential Transmit/Receive + | Bi-directional |
| TXD/RXD- | Differential Transmit/Receive - | Bi-directional |
| **Common to all protocols:** | | |
| DIO A – H | Digital I/O lines | Programmable |
| GND | Ground | -- |
| NC | Not Connected | -- |

# 6. BOARD CONFIGURATION

Refer to the Drawing of Emerald-MM-8P on page 4 for locations of the configuration items mentioned here.

## 6.1 Port and Interrupt Register Address Selection

Each peripheral board in the computer system must have a unique I/O address or block of addresses. Emerald-MM actually uses nine I/O address blocks: one for each of the eight serial ports and one for the board's configuration registers.

Each port's address block consists of 8 consecutive addresses, while the configuration and interrupt status register block occupies four addresses. Jumper block J9 in the lower left corner of the board is used for configuration of the board's base address. The serial port I/O addresses are set in software once this address is known.

To help with the translation between jumper settings and addresses, remember that each jumper installed corresponds to a 0, and each jumper out corresponds to a 1. The 4 jumpers D C B A correspond to address bits 9 8 7 6, and address bits 5 – 0 are forced to 0 to determine the base address.

**Board Configuration Register Addresses**

| D | C | B | A | (Base Address) Addr. Pointer Register | Data Register | DIO Direction Register, Interrupt Status Register | DIO Register |
|---|---|---|---|---|---|---|---|
| In | In | In | In | Invalid setting | | | |
| In | In | In | Out | Invalid setting | | | |
| In | In | Out | In | Invalid setting | | | |
| In | In | Out | Out | Invalid setting | | | |
| In | Out | In | In | 100 | 101 | 102 | 103 |
| In | Out | In | Out | 140 | 141 | 142 | 143 |
| In | Out | Out | In | 180 | 181 | 182 | 183 |
| In | Out | Out | Out | 1C0 | 1C1 | 1C2 | 1C3 |
| Out | In | In | In | 200 | 201 | 202 | 203 |
| Out | In | In | Out | 240 | 241 | 242 | 243 |
| Out | In | Out | In | 280 | 281 | 282 | 283 |
| Out | In | Out | Out | 2C0 | 2C1 | 2C2 | 2C3 |
| Out | Out | In | In | 300 | 301 | 302 | 303 |
| Out | Out | In | Out | 340 | 341 | 342 | 343 |
| Out | Out | Out | In | 380 | 381 | 382 | 383 |
| Out | Out | Out | Out | 3C0 | 3C1 | 3C2 | 3C3 |

### 6.2 RS-422 / RS-485 Cable Endpoint Termination

In RS-422 or RS-485 networks, termination resistors are normally installed at the endpoints of the cables to minimize reflections on the lines. Emerald-MM-8P provides 120Ω resistors for this purpose. To enable resistor termination for a port, install jumpers in the locations T and R of that port's corresponding configuration jumper block (J5 – J8). Termination is only needed, and should only be used, at the cable endpoints. Enabling these termination resistors at each end of the cable results in an effective impedance of 60Ω. Installing termination resistors at additional points in the network may cause overloading and failure of the line drivers due to the lower impedance caused by multiple resistors in parallel.

**Jumper Blocks J5-J8**

Using jumper blocks J5-J8, 120Ω termination resistors can be added individually for each of the eight serial ports as follows. The default configuration is with no jumpers installed.

| **Termination Feature** | **J5 Jumper Settings** (horizontal jumpers) | **J6 Jumper Settings** (horizontal jumpers) | **J7 Jumper Settings** (horizontal jumpers) | **J8 Jumper Settings** (horizontal jumpers) |
|---|---|---|---|---|
| RS-422 120Ω Terminal Resistor | Port 1:<br>Jumper on 1T pins<br>Jumper on 1R pins | Port 3:<br>Jumper on 3T pins<br>Jumper on 3R pins | Port 5:<br>Jumper on 5T pins<br>Jumper on 5R pins | Port 7:<br>Jumper on 7T pins<br>Jumper on 7R pins |
| RS-422 120Ω Terminal Resistor | Port 2:<br>Jumper on 2T pins<br>Jumper on 2R pins | Port 4:<br>Jumper on 4T pins<br>Jumper on 4R pins | Port 6:<br>Jumper on 6T pins<br>Jumper on 6R pins | Port 8:<br>Jumper on 8T pins<br>Jumper on 8R pins |
| RS-485 120Ω Terminal Resistor | Port 1:<br>Jumper on 1T pins<br>No jumper on 1R pins | Port 3:<br>Jumper on 3T pins<br>No jumper on 3R pins | Port 5:<br>Jumper on 5T pins<br>No jumper on 5R pins | Port 7:<br>Jumper on 7T pins<br>No jumper on 7R pins |
| RS-485 120Ω Terminal Resistor | Port 2:<br>Jumper on 2T pins<br>No jumper on 2R pins | Port 4:<br>Jumper on 4T pins<br>No jumper on 4R pins | Port 6:<br>Jumper on 6T pins<br>No jumper on 6R pins | Port 8:<br>Jumper on 8T pins<br>No jumper on 8R pins |

### 6.3 Interrupt Sharing

On the PC/104 bus, interrupt levels may be shared by multiple devices. For this reason, the interrupt is driven to a logic high level by the device requesting service, and when the device is serviced it tristates the line rather than driving it low. This technique avoids contention by two devices trying to drive the line with opposing logic levels.

In order to guarantee valid logic levels on the line when the device is not requesting service, each active interrupt level requires a 1KΩ pulldown resistor. Only one such resistor should be used on each active interrupt line. For each interrupt level availabe on Emerald-MM-8P, there is a position on jumper block J9 with that interrupt level number for enabling the pulldown resistor. Install a jumper in this position to connect the resistor, and remove the jumper to disconnect the resistor.

### 6.4 High Baud Rate UART Clock Selection

For those applications that require high baud rates, jumper pins CK are provided on jumper block J9 to select a high baud rate. Placing a vertical jumper on the CK pin pair causes the baud rate to become 4x the programmed rate, enabling a 460.8kbps top baud rate. With no jumper installed on the CK pins (default), the baud rate is the programmed rate with a maximum rate of 115kbps.

### 6.5 Power Up Port Enable/Disable

The serial ports on EMM-8P-XT can be configured to be enabled or disabled on power-up. To enable the ports on power-up, remove the jumper from location PD on jumper block J9 (default setting). To disable the ports on power-up, install the jumper vertically on the PD pin pair of jumper block J9. If the PD jumper is installed, the ports will still be automatically configured for the programmed addresses and IRQ settings, but they will need to be enabled by setting the ENABLE bit (see Sections 7 and 8).

### 6.6 Pull-up/pull-down Resistors for Port 4

In RS-422 / RS-485 mode on port 4 only, 4.7K ohm resistors can be jumper-configured to drive the circuit to an inactive state when the pins are left unconnected using jumper block J11 as follows. The default is with no jumpers installed.

For RS-422, install vertical jumpers in all four positions T+ T- R+ R- to enable active pull-up/down on the TX and RX line pairs.

For RS-485, install vertical jumpers in the two positions T+ and T- to enable active pull-up/down on the combination TX/RX line pair.

| **Feature** | **J11 Jumper Settings** (vertical jumpers) |
|---|---|
| RS-422 Active Pull-up/down | Jumper on T+ pins<br>Jumper on T- pins<br>Jumper on R+ pins<br>Jumper on R- pins |
| RS-485 Active Pull-up/down | Jumper on T+ pins<br>Jumper on T- pins<br>No jumper on R+ pins<br>No jumper on R- pins |
| No Active Pull-up/down (default) | No jumpers on any pins |

## 7. I/O REGISTER MAP

**Emerald-MM-8P Register Map**

| Base Address + | Write | Read |
|---|---|---|
| 0 | Address pointer / enable register | Address pointer / enable register |
| 1 | Data for address / IRQ no. | Readback of address registers |
| 2 | Digital I/O direction register | Interrupt status register |
| 3 | Digital output register | Digital input / readback register |
| 4 | EEPROM read/write + address | EEPROM busy status |
| 5 | EEPROM data (write operation) | EEPROM data (read operation) |
| 6 | Reload command | N/A |
| 7 | N/A | N/A |

Emerald-MM-8P contains 18 additional registers for selecting the address and and interrupt level for each port. These registers are accessed through the address pointer register at Base + 0. The register map is shown below:

| Register No. | Function |
|---|---|
| 0 | Port 0 Address |
| 1 | Port 1 Address |
| 2 | Port 2 Address |
| 3 | Port 3 Address |
| 4 | Port 4 Address |
| 5 | Port 5 Address |
| 6 | Port 6 Address |
| 7 | Port 7 Address |
| 8 | Port 0 IRQ No. |
| 9 | Port 1 IRQ No. |
| 10 | Port 2 IRQ No. |
| 11 | Port 3 IRQ No. |
| 12 | Port 4 IRQ No. |
| 13 | Port 5 IRQ No. |
| 14 | Port 6 IRQ No. |
| 15 | Port 7 IRQ No. |
| 16 | Ports 0-3 Protocol Configuration |
| 17 | Ports 4-7 Protocol Configuration |

To write data to a register, first write the number of that register (0 – 17) to the board's address pointer / enable register at Base address + 0. Then write the data to the board's data register at Base address + 1.

To program an address for a port, write the upper 7 bits of the 10 bit I/O address into bits 6 – 0 of the address register for that port. The value written to the address register is therefore the desired I/O address divided by 8. All I/O addresses should be on 8 byte boundaries between 100 Hex and 3F8 Hex. Addresses below 100 Hex are reserved for CPU functions. A value of 00 Hex for a port address will disable that port.

To select an interrupt level for a port, write the desired interrupt level to that port's interrupt level register. Valid interrupt levels are 2, 3, 4, 5, 6, 7, 10, 11, 12, and 15. Writing any other value to the interrupt level register including 00 Hex will cause that port not to generate interrupts.

Bit 7 of Base address + 0 is the port enable bit and must be set after manual loading of port addresses and interrupts in order to enable serial port operation. On power-up or reset, all ports are automatically configured with the EEPROM values. If the PD jumper on jumper block J9 is not installed, the ports are also automatically enabled. If the PD jumper is installed, the ports must be manually enabled by writing to bit 7.

To configure the serial protocol for a port the pair of bits assigned to that port must be configured as shown below:

REGISTER #16

| Bit No. | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | Port 3 CFG1 | Port 3 CFG0 | Port 2 CFG1 | Port 2 CFG0 | Port 1 CFG1 | Port 1 CFG0 | Port 0 CFG1 | Port 0 CFG0 |

REGISTER #17

| Bit No. | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | Port 7 CFG1 | Port 7 CFG0 | Port 6 CFG1 | Port 6 CFG0 | Port 5 CFG1 | Port 5 CFG0 | Port 4 CFG1 | Port 4 CFG0 |

| CFG1 | CFG0 | PROTOCOL |
|---|---|---|
| 0 | 0 | RS232 |
| 0 | 1 | RS422 |
| 1 | 0 | RS485 with Echo |
| 1 | 1 | RS485 without Echo |

# 8. I/O REGISTER DETAIL

## 8.1 Address Pointer / Enable Register (Base Address + 0, Read/Write)

This register selects the address or IRQ register to be programmed and also enables the serial ports. The value written to this register can be read back for diagnostic purposes.

After writing the address to this register, the appropriate data is written to the data register at Base address + 1. See 8.2 below.

| Bit No. | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | ENABLE | X | X | X | A3 | A2 | A1 | A0 |

ENABLE Enables chip selects for the 8 serial ports. 1 = enable, 0 = disable

On power-up or reset, all ports are automatically configured with the EEPROM values. If the PD jumper on jumper block J9 is not installed, the ports are also automatically enabled. If the PD jumper is installed, the ports must be manually enabled by writing to bit 7.

When manually programming the address and IRQ registers, this bit must be set after programming is complete in order to enable the serial ports.

X Not used

A3 – 0 Address of internal configuration register:

0 – 7 Address registers for ports 0 – 7 respectively

8 – 15 Interrupt level register for ports 0 – 7 respectively

## 8.2 Address / IRQ / Protocol Data Register (Base Address + 1, Write)

This register is used to write data to the register selected with the address / enable register described above. The data must be written to this register after the address is selected.

Note that writing to the board's serial port address and IRQ registers does **not** cause a write-through to the corresponding EEPROM registers. The user must explicitly write the data to the EEPROM to store these settings for future use when the board is reset or the power is cycled.

| Bit No. | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | X | D6 | D5 | D4 | D3 | D2 | D1 | D0 |

X Not used

D6 – 0 Register data;

For address registers, D6 – 0 contains the upper 7 bits of the 10-bit base address of the serial port. Valid port base addresses are 100 Hex to 3F8 Hex.

For interrupt level registers, Only D3 – 0 are used. Valid values are 2, 3, 4, 5, 6, 7, 10, 11, 12, and 15. Any other value will prevent interrupts from operating on the selected port.

**I/O Address example**

Desired I/O address = 140 Hex = 0 1 0 1 0 0 0 0 0

Only the upper 7 bits are needed. The three lowest bits are always 0, resulting in all addresses being on 8-byte boundaries.

Necessary bits = 0 1 0 1 0 0 0 = 28 Hex

An easy way to generate these bits is to divide the I/O address by 8 or shift right 3 places.

### 8.3 Address Register Readback (Base Address + 1, Read)

This register provides a means to read back the current address settings for Ports 1 – 8 as a diagnostic tool to verify that the board is present and responding. Using this technique, all 8 address registers can be read back, but the IRQ registers cannot be read back. All 18 register values can be read back from the EEPROM; see page 15 for details.

### 8.4 Digital I/O Direction Register (Base Address + 2, Write)

This register determines the direction of each of the 8 digital I/O lines. The direction of each bit can be programmed individually. This register is cleared to 0 on reset or power-up (all bits in input mode).

| Bit No. | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | DIR 7 | DIR 6 | DIR 5 | DIR 4 | DIR 3 | DIR 2 | DIR 1 | DIR 0 |

Dir 7 – 0 0 = input, 1 = output

### 8.5 Interrupt Status Register (Base Address + 2, Read)

The interrupt status register indicates the status of each port's interrupt request line. It operates regardless of whether interrupt sharing is enabled (see below). If two or more ports are sharing the same interrupt level, the status register will still indicate the correct status of each port's interrupt request line. If different ports are sharing different interrupt levels, the status register will still operate properly.

| Bit No. | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | INT 7 | INT 6 | INT 5 | INT 4 | INT 3 | INT 2 | INT 1 | INT 0 |

**Definitions:**

INT 7 – 0 Status of interrupt request for each port:

0 = no interrupt request active
1 = interrupt request active

### 8.6 Digital I/O Output Register (Base Address + 3, Write)

This register programs the digital output lines on the I/O headers. Any line set to output mode using the configuration register at base + 2 will be set to the value specified in this register. Any I/O line in input mode will not be affected.

The digital output register is cleared to 0 on power up or system reset.

| Bit No. | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | Dout 7 | Dout 6 | Dout 5 | Dout 4 | Dout 3 | Dout 2 | Dout 1 | Dout 0 |

Dout 7 – 0 Set digital output line to value specified

### 8.7 Digital Input Register (Base Address + 3, Read)

This register returns the state of the 8 digital I/O lines on the I/O headers. Any line in output mode will be read back. Any line in input mode will be read as the state of the pin on the I/O header.

Input pins that are not driven externally will float. They will have an unpredictable readback value, and the value may change on successive read operations. This is normal behavior for a floating input pin.

| Bit No. | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | DIO 7 | DIO 6 | DIO 5 | DIO 4 | DIO 3 | DIO 2 | DIO 1 | DIO 0 |

DIO 7 – 0 Logic state of I/O line 7 - 0

### 8.8 EEPROM Command and Address Register (Base Address + 4, Write)

This register is used to initiate an EEPROM read or write operation. First the data is written to Base + 5, then the address and read/write bit are written to this register to initiate the operation. After writing the operation has started, the application program should monitor the Busy bit by reading this address to know when the operation is complete.

| Bit No. | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | R/W | EEA6 | EEA5 | EEA4 | EEA3 | EEA2 | EEA1 | EEA0 |

R/W Read/Write bit: 1 = write operation, 0 = read operation

EEA6-0 EEPROM address; The EEPROM has 256 bytes; only the lowest 64 are accessible. Only the lowest 16 contain configuration information for the board. The other registers are available for customer application.

### 8.9 EEPROM Busy Status (Base Address + 4, Read)

The Busy bit indicates whether the EEPROM is busy with a read, write, or reload operation. The application program must monitor this bit after each read, write, or reload operation before proceeding to another one. If a new EEPROM operation is commenced without waiting for the previous one to finish, the new operation will be ignored.

| Bit No. | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | BUSY | X | X | X | X | X | X | X |

BUSY EEPROM Busy status: 1 = busy, 0 = idle

X Not used

### 8.10 EEPROM Data Register (Base Address + 5, Read/Write)

When writing to the EEPROM, the data is first written to this register before the address and write bit are written to Base + 4.

When reading from the EEPROM, the address to read from is first written to Base + 4. Then the program must monitor the BUSY bit in Base + 4. When it is 0, the program may read the EEPROM data from this register.

| Bit No. | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | EED7 | EED6 | EED5 | EED4 | EED3 | EED2 | EED1 | EED0 |

EED7 – 0 EEPROM data

### 8.11 Configuration Register Reload Command (Base Address + 6, Write)

This register is used to cause a reload of the contents of the EEPROM into the board's configuration registers. This can be done at any time, for example to recall known good settings in case the user loads invalid data into the registers.

| Bit No. | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | RELOAD | X | X | X | X | X | X | X |

RELOAD Set to 1 to force a reload of the 8 address settings and 8 interrupt level settings from the EEPROM into the board. The BUSY bit (Base + 4 bit 7) will go high and stay high until the reload is complete.

X Not used

# 9. EEPROM OPERATION

## 9.1 EEPROM Map and Description

Emerald-MM-8P V1 has an EEPROM for storage of the address and interrupt level settings for each serial port. The EEPROM has 256 bytes total, of which the lowest 64 are addressible. Only the lowest 18 registers in the EEPROM are used. The first 8 locations (0-7) are used to store the base address values for the 8 serial ports. The second 8 locations (8-15) are for the 8 interrupt levels (IRQ numbers). The last two locations (16 and 17) are used to store the port protocol for each port. The memory map of the EEPROM is identical to the register map for the addresses and interrupts on Emerald-MM-8P:

| EEPROM Address | Function |
|---|---|
| 0 | Port 0 Address |
| 1 | Port 1 Address |
| 2 | Port 2 Address |
| 3 | Port 3 Address |
| 4 | Port 4 Address |
| 5 | Port 5 Address |
| 6 | Port 6 Address |
| 7 | Port 7 Address |
| 8 | Port 0 IRQ No. |
| 9 | Port 1 IRQ No. |
| 10 | Port 2 IRQ No. |
| 11 | Port 3 IRQ No. |
| 12 | Port 4 IRQ No. |
| 13 | Port 5 IRQ No. |
| 14 | Port 6 IRQ No. |
| 15 | Port 7 IRQ No. |
| 16 | Ports 0-3 Protocol Configuration |
| 17 | Ports 4-7 Protocol Configuration |

The address values stored in EEPROM are the upper 7 bits of the 10-bit serial port address. Each serial port uses 8 registers, so the binary base address of each serial port always ends in 000. To determine the value to store in the EEPROM, divide the desired base address by 8:

Desired base address = 120 Hex = 0 1  0 0 1 0  0 0 0 0 = 288 Decimal

EEPROM value = 288 / 8 = 36 Decimal = 24 Hex = 0 1 0  0 1 0 0

These are the 7 uppermost bits of the original base address. This value would be written to the selected port's address location in the EEPROM to program that port for

The IRQ numbers stored in EEPROM are the actual IRQ numbers without any changes. Each port may be programmed for its own IRQ number, or any number of ports may share an IRQ. Not all IRQs are available in all computers. You will need to test for availability and operability of the selected IRQ.

**NOTE:** The serial port base addresses must be distinct from each other and must also be distinct from the board's base address. If any serial port's address is programmed to overlap with the board's base address, that port will not be accessible, and the address will have to be reconfigured.

## 9.2 How to Use the EEPROM

There are three available EEPROM operations: write data, read data, and reload data.

The write and read operations store data in the EEPROM but have no effect on the board's configuration settings. The reload operation updates the board's configuration settings to match the values stored in the EEPROM.

Note that writing to the board's serial port address and IRQ registers does **not** cause a write-through to the corresponding EEPROM registers. The user must explicitly write the data to the EEPROM to store these settings for future use when the board is reset or the power is cycled.

The EEPROM contains 256 bytes. However only locations 0 – 63 may be accessed.

Only EEPROM addresses 0 – 17 are used to store data for the configuration of Emerald-MM-8P. The remaining locations are available for customer application use.

**EPROM Write Operation:**

1. Write data to Base + 5
2. Write 6-bit address including Write bit (bit 7 = 1) to Base + 4
3. Monitor Busy bit (bit 7) in base + 4 until it is 0

**EEPROM Read Operation:**

1. Write 6-bit address to Base + 4 (Bit 7 = 0 for read)
2. Monitor Busy bit (bit 7) in base + 4 until it is 0
3. Read data from Base + 5

**EEPROM Reload Operation:**

1. Write 0x80 (128) to Base + 6 to initiate Reload operation
2. Monitor Busy bit (bit 7) in base + 4 until it is 0

# 10. INSTALLING EMERALD-MM-8P IN YOUR SYSTEM

Diamond Systems provides utility programs to configure the Emerald-MM-8P board for use in your computer system. For DOS and Windows 9x applications, the program will configure the address and interrupt settings, store them in the EEPROM on the board, and allow you to store them in a file which can be used later to program additional boards with the same configuration. For Windows NT applications, the program will additionally configure the NT registry with the proper settings according to the configuration you select.

The configuration programs and instructions are in the zip file EMM8.zip that is included in the board's software diskette. For DOS and Windows 9x applications, complete instructions are in the file readme.txt in the DOS-9x folder, and the application program is called eepconf.exe. For Windows NT applications, complete instructions are in the file EMM8-NT.txt in the NT folder, and the application is called Emm8Conf.exe.

The instructions below may be used to manually set up Windows NT to run with the board. However these instructions are not needed if Emm8Conf.exe is used.

**1.** Run REGEDT32.EXE and go to the following dialog box:

Key_Local_Machine \ System \ CurrentControlSet \ Service \ Serial \ Parameters

**2.** Add a new key for each serial port by selecting Edit \ Add Key. The following parameters need to be specified for each serial port:

**SerialN** (N = serial port number, 1, 2, 3, 4, etc.):

| Parameter | Type | Value, Comments |
|---|---|---|
| DosDevices | REG_SZ | Name of port, e.g. COM5, COM6 |
| ForceFifoEnable | REG_DWORD | 0x1 for yes |
| Interrupt | REG_DWORD | IRQ level in Hex format, e.g. 0x5 for 5 or 0xA for 10 |
| InterruptStatus | REG_DWORD | Address of interrupt status register in Hex, e.g. 0x102; See page 8 for status register addresses |
| PortAddress | REG_DWORD | Address or port in Hex, e.g. 0x120 for Hex 120 |
| PortIndex | REG_DWORD | Bit position in status register: 0x1 for LSB through 0x8 for MSB (Note this is NOT the weighted bit value); See page 14 for details |
| SharedInterrupts | REG_DWORD | 0x1 for yes, 0x0 for no |

**3.** Exit REGEDT32.EXE and restart NT.

See the example parameter values on the following page.

**Windows NT Registry Setup Example**

The following example is for 8 ports on an EMM-8P-XT board installed on a CPU that already contains 2 serial ports called COM1 and COM2. Note that all 8 ports on the Emerald-MM-8P board share the same interrupt status register, but the bit position changes for each port. The settings shown are the factory settings for the board. All ports are set to share the same interrupt number.

Configuration selections:

| | Port 1 | Port 2 | Port 3 | Port 4 | Port 5 | Port 6 | Port 7 | Port 8 |
|---|---|---|---|---|---|---|---|---|
| Address | 0x100 | 0x108 | 0x110 | 0x118 | 0x120 | 0x128 | 0x130 | 0x138 |
| IRQ No. | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |

Board base address: 0x200
Interrupt status register: 0x202

**Serial3:**

| | | |
|---|---|---|
| DosDevices | REG_SZ | COM3 |
| ForceFifoEnable | REG_DWORD | 0x1 |
| Interrupt | REG_DWORD | 0x7 |
| InterruptStatus | REG_DWORD | 0x202 |
| PortAddress | REG_DWORD | 0x100 |
| PortIndex | REG_DWORD | 0x1 |
| SharedInterrupts | REG_DWORD | 0x1 |

**Serial4:**

| | | |
|---|---|---|
| DosDevices | REG_SZ | COM4 |
| ForceFifoEnable | REG_DWORD | 0x1 |
| Interrupt | REG_DWORD | 0x7 |
| InterruptStatus | REG_DWORD | 0x202 |
| PortAddress | REG_DWORD | 0x108 |
| PortIndex | REG_DWORD | 0x2 |
| SharedInterrupts | REG_DWORD | 0x1 |

**Serial5:**

| | | |
|---|---|---|
| DosDevices | REG_SZ | COM5 |
| ForceFifoEnable | REG_DWORD | 0x1 |
| Interrupt | REG_DWORD | 0x7 |
| InterruptStatus | REG_DWORD | 0x202 |
| PortAddress | REG_DWORD | 0x110 |
| PortIndex | REG_DWORD | 0x3 |
| SharedInterrupts | REG_DWORD | 0x1 |

**Serial6:**

| | | |
|---|---|---|
| DosDevices | REG_SZ | COM6 |
| ForceFifoEnable | REG_DWORD | 0x1 |
| Interrupt | REG_DWORD | 0x7 |
| InterruptStatus | REG_DWORD | 0x202 |
| PortAddress | REG_DWORD | 0x118 |
| PortIndex | REG_DWORD | 0x4 |
| SharedInterrupts | REG_DWORD | 0x1 |

**Serial7:**

| | | |
|---|---|---|
| DosDevices | REG_SZ | COM7 |
| ForceFifoEnable | REG_DWORD | 0x1 |
| Interrupt | REG_DWORD | 0x7 |
| InterruptStatus | REG_DWORD | 0x202 |
| PortAddress | REG_DWORD | 0x120 |
| PortIndex | REG_DWORD | 0x5 |
| SharedInterrupts | REG_DWORD | 0x1 |

**Serial8:**

| | | |
|---|---|---|
| DosDevices | REG_SZ | COM8 |
| ForceFifoEnable | REG_DWORD | 0x1 |
| Interrupt | REG_DWORD | 0x7 |
| InterruptStatus | REG_DWORD | 0x202 |
| PortAddress | REG_DWORD | 0x128 |
| PortIndex | REG_DWORD | 0x6 |
| SharedInterrupts | REG_DWORD | 0x1 |

**Serial9:**

| | | |
|---|---|---|
| DosDevices | REG_SZ | COM9 |
| ForceFifoEnable | REG_DWORD | 0x1 |
| Interrupt | REG_DWORD | 0x7 |
| InterruptStatus | REG_DWORD | 0x202 |
| PortAddress | REG_DWORD | 0x130 |
| PortIndex | REG_DWORD | 0x7 |
| SharedInterrupts | REG_DWORD | 0x1 |

**Serial10:**

| | | |
|---|---|---|
| DosDevices | REG_SZ | COM10 |
| ForceFifoEnable | REG_DWORD | 0x1 |
| Interrupt | REG_DWORD | 0x7 |
| InterruptStatus | REG_DWORD | 0x202 |
| PortAddress | REG_DWORD | 0x138 |
| PortIndex | REG_DWORD | 0x8 |
| SharedInterrupts | REG_DWORD | 0x1 |

# 11. SPECIFICATIONS

**Serial Ports**

| | |
|---|---|
| Number of serial ports: | 8 |
| Protocols: | EMM-8P-XT: RS-232, RS-422, RS-485 |
| Maximum baud rate: | 115kbps standard version<br>460.8kbps available via jumper selection |
| Communications parameters: | 5, 6, 7, or 8 data bits; Even, odd, or no parity |
| Short circuit protection: | All outputs protected against continuous short circuit |

**RS-232 mode:**

| | |
|---|---|
| Input impedance: | 3KΩ min |
| Input voltage swing: | ±30V max |
| Output voltage swing: | ±5V min, ±7V typical |

**RS-422, RS-485 modes:**

| | |
|---|---|
| Differential input threshold: | -0.2V min, +0.2V max |
| Input impedance: | 12KΩ min |
| Input current: | +1.0mA max ($V_{IN}$ = 12V)<br>-0.8mA max ($V_{IN}$ = -7V) |
| Differential output voltage: | 2.0V min ($R_L$ = 50Ω) |
| High/low states differential output voltage symmetry: | 0.2V max |

**Digital I/O** **(At $V_{CC}$ = 5.0VDC)**

| | |
|---|---|
| No. of I/O lines: | 8 in, 8 out |
| Input voltage: | Low: -0.3V min, 0.8V max<br>High: 2.0V min, 5.3V max |
| Output voltage: | Low: 0.0V min, 0.4V max ($I_{OL}$ = 6mA max)<br>High: 3.7V min, 5.0V max ($I_{OH}$ = -4mA max) |

**General**

| | |
|---|---|
| I/O header: | 2 40-position (2x20) .025” square pin header on .1” centers; Headers mate with standard ribbon cable (IDC) connectors |
| Dimensions: | 3.55” x 3.775” LxW (PC/104 standard) |
| Power supply: | +5VDC ±10% |
| Current consumption: | 160mA typical, all outputs unloaded |
| Operating temperature: | -40°C to +85°C (Industrial range) |
| Operating humidity: | 5% to 95% noncondensing |
| PC/104 bus: | 8 bit and 16-bit bus headers are installed and used (16-bit header is used for interrupt levels only) |